DATE:

TITLE: COMPUTATION OF RPP, TI, DPTI, TTI AND EVR ON-LINE

AUTHORS: D.G. Bjoraker, M.D. and P.R. Knight, M.D., Ph.D.

AFFILIATION: Department of Anesthesiology, University of Michigan Medical Center
Ann Arbor, Michigan 48109

Introduction. A major goal in the anesthetic care of patients with coronary artery disease is maintaining a favorable balance of myocardial oxygen supply and demand. The derived values of rate pressure product (RPP), triple index (TI), and tension time index (TTI) may reflect the demand portion of that balance, diastolic pressure time index (DPTI) the supply portion, and endocardial viability ratio (EVR) the overall subendocardial balance.[1,2] This abstract presents a method of on-line intraoperative calculation and display of these parameters by a desktop computer. A summary of data from its clinical application is presented.

Computer hardware and software. Alternately five second bursts the systemic arterial waveform and the pulmonary artery waveform from the HP78205A module of a Hewlett-Packard (HP) medical monitoring system are processed by a HP47310A A/D converter at a 200 Hz rate and read by a HP system 45 desktop computer. The system 45 consists of a CRT display with graphics capability, a thermal printer, dual tape cartridge drives, and enhanced BASIC language programming. Program and data required 32,000 bytes of memory. The arterial systolic (SP), diastolic (DP) and mean pressures (MP), the pulmonary artery end diastolic pressure (PAEDP), and the heart rate (HR) are extracted from the incoming bursts and displayed numerically and on a trend plot. A cardiac cycle is selected by the computer from the arterial and pulmonary artery data and, if free of artifact and containing an identifiable dicrotic notch (to serve as an estimate of end systole), calculates (table) and plots the derived values. Alternatively, the user may choose to operate in a manual mode. The PAEDP or pulmonary capillary wedge pressure (WP) is entered from the keyboard, a cardiac cycle selected, enlarged, and replotted, and the user marks the dicrotic notch with a cursor. Graphic display of the waveform, the derived values, and areas integrated are then provided (figure). Manual mode facilitates trouble-shooting of signal input problems.

Clinical application. In 5 coronary artery bypass patients, data was analyzed 1) prior to anesthetic induction, 2) immediately prior to intubation, 3) immediately after intubation, 4) 15 minutes after intubation, 5) immediately after sternotomy. Anesthetic technique was not standardized as a range of hemodynamic responses was desired.

Results. Both the index value and its change during the intervals between measurements were compared. Correlation coefficients for the indices (n=30) are shown above the identity line. Those for changes in the indices (n=25) are below the line.

Correlation Coefficients

	RPP	TI	EVR	DPTI	TTI	
RPP		.72	*	*	.93	RPP
TI	.82		-.74	*	.71	TI
EVR	-.78	.-.73		.63	*	EVR
DPTI	*	*	*		*	DPTI
TTI	.93	.81	-.79	.63		TTI

*Correlations with $p > .005$

Discussions. The on-line availability of derived indices will maximize their value by allowing their use in clinical decision making. The readily available RPP is considered to be a correlate of myocardial oxygen consumption.[3] Based on the high correlation of TTI and its changes with anesthetic events to those of RPP, the TTI may offer little more than RPP. The low correlation of DPTI with other derived values may represent information not in the other indices. However, the observations made do not assess the efficacy of DPTI as an index of myocardial oxygen supply. The continuous recording and trend display of indices including the TTI, DPTI, and EVR, which require pulmonary artery catheter data, offer additional information on the efficacy of manuevers used in the anesthetic care of patients with severe coronary artery disease.

References

1. Philips PA, Marty AT, Miyamoto AM, et al: A clinical method for detecting subendocardial ischemia after cardiopulmonary bypass. J Thorac Cardiovasc Surg 69:30-39, 1975
2. Hoffman JIE, Buckberg GD: The myocardial supply:demand ratio--a critical review. Am J Cardiol 41:327-332, 1978
3. Wilkinson PL, Tyberg JV, Moyers JR, et al: Correlates of myocardial oxygen consumption when afterload changes during halothane anesthesia in dogs. Anesth Analg 59:233-239, 1980

Table: Derivations

RPP = HR x SP ($mmHg \cdot min^{-1}$)
TI = HR x SP x PAEDP ($mmHg^2 \cdot min^{-1}$)
EVR = DPTI / TTI
DPTI = (mean pressure in diastole - PAEDP) x duration of diastole x HR ($mmHg \cdot sec \cdot min^{-1}$)
TTI = mean pressure in systole x duration of systole x HR ($mmHg \cdot sec \cdot min^{-1}$)

Figure: Manual Display